USE OF SOLAR ENERGY RESOURCES IN THE TERRITORY OF THE REPUBLIC OF AZERBAIJAN

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Abstract

The article proposes a method for calculating the solar energy potential for the Republic of Azerbaijan and presents the obtained results. The annual amount of sunlight falling on the territory of the Republic of Azerbaijan has been scientifically analyzed. The results obtained on a sample solar collector on the use of solar thermal energy are presented. The experiments were carried out in the summer months and the results show that the highest temperature in the solar collector during the day is obtained in the second half of the day. Here, as a result of the experiments, the dependence of the temperature on the hours of the day is graphed.

Keywords: Solar energy, solar collector, solar energy potential, thermal energy, technical potential

I. Introduction

The development of green energy and the access of green energy to world markets are currently the priority of Azerbaijan's energy policy. Expanding the use of renewable energy sources in the field of energy in our country has been put forward as a priority task by our state, and the goal of increasing the share of renewable energy in the installed capacity of electricity to 30 percent by 2030 has been determined. Also, the 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP29), which will be held in our country, will create new approaches to climate change and promote cooperation between various stakeholders. Everyone in the world will once again see that our agenda is about green energy. To combat climate change, significantly reduce greenhouse gas emissions to reduce risks in this area, achieve technology transfer to achieve low-carbon development worldwide, finance renewable energy, as well as find other innovative solutions to reduce emissions and adapt to climate impacts, it is important to expand policies promoting the use of renewable energy, grid integration and energy efficiency measures. Expanding the use of solar energy is one of the important tasks in the direction of reducing greenhouse gases in our country. Huge projects are being implemented in our country in the direction of purchasing electricity from solar energy, but the production of thermal energy is just as important.

The Republic of Azerbaijan is rich in solar, wind and other renewable energy sources and has highly qualified specialists for their use. The use of ecologically and economically favorable solar energy is of great importance in our country. The values of insolation in cloudless air are 800÷1000 $kW{\cdot}h/m^2$ during the year for the Absheron peninsula and the Caspian coastal strip. The number of sunny hours here is 2500 hours per year. For the Autonomous Republic of Nakhchivan, these figures are more appropriate, 1100÷1200 kWh/m^2 and 2900 hours, respectively.

Modern photovoltaic modules are solar installations available to provide industrial facilities, residential areas and commercial facilities with high technical characteristics. At the same time, these devices convert direct current energy into alternating current energy by means of an inverter and are used to create a reliable energy source.

Among the methods of using solar energy, two options of photothermal conversion are used more: heat supply of residential, communal and agricultural enterprises; obtaining electricity by means of steam and gas turbines.

The first option is used more often, there is little transition to the use of the second option.

The potential amount of solar energy of the region means the total amount of solar radiation falling on the territory of the region during one year and depends on the climatic conditions of this region (Eum, kWh/(m²·year)). The linear size of potentially measured zones is taken up to 200 km.

II. Methods

Cadastral data is used to determine solar energy potential. The displayed data should reflect the spatio-temporal dynamics of solar radiation fall and the characteristics of meteorological factors affecting it. The following information is usually included in the solar cadastre: average monthly and average annual total cloudiness; probability of clear and cloudy skies; clear air attendance coefficient; average monthly and average annual duration of solar radiation; average hourly values of the main elements of solar radiation incident on a horizontal surface under conditions of medium cloudiness. Usually 0.1% of the incident solar radiation is attributed to the technical potential. The annual duration (in hours) of the length of the day at the 38-42nd parallels of heliograph observations at the meteorological stations in the territory of the Republic of Azerbaijan was determined.

At the limit of the atmosphere, the solar radiation falling on the horizontal plane can be calculated analytically. Actinometric observations cannot be made at all locations, but analytically, it is possible to calculate the horizontal solar radiation falling on the surface at the upper boundary of the atmosphere at any latitude with great accuracy. The values of solar radiation were calculated in 1 degree increments for latitude circles covering the entire territory of the Republic of Azerbaijan, i.e. from the 38th latitude to the 42nd latitude, and are shown graphically in Figure 1. As can be seen from the graph, due to the small size of the area, solar radiation values are almost unchanged in the hot season, while in the cold season, small differences in latitude are observed.

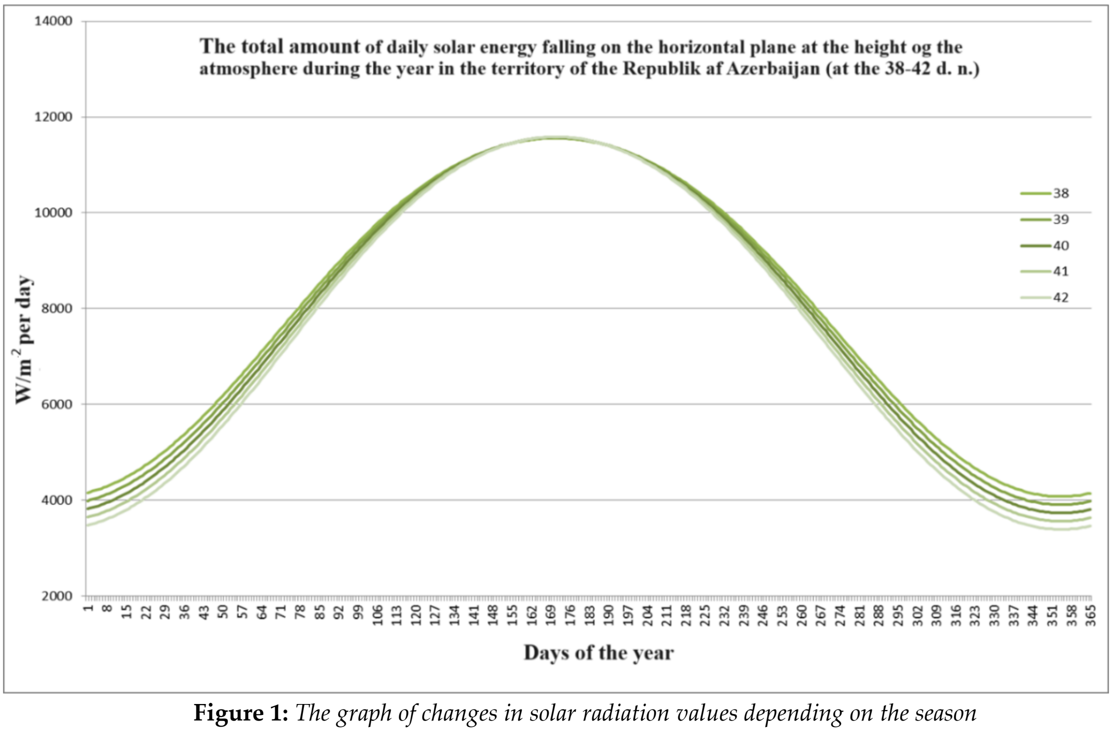

Figure 1: *The graph of changes in solar radiation values depending on the season*

The technical potential of heat and electric energy of the area is taken as the sum of heat and electric energy produced by the taken technical means. During the determination of thermal energy, the technical characteristics of the technical device, i.e. the solar collector, are taken. In the determination of electric power, the energy characteristics of photoelectric devices are considered as the basis.

III. Results

The technical potential of Solar Energy is calculated as follows:

$$E_{tex} = E_{tot} * S * \tau * \eta_{sp} * \eta_0 \quad (1)$$

$\boldsymbol{E_{tex}}$- technical potential of solar energy
$\boldsymbol{E_{tot}}$- solar energy total potential
$\boldsymbol{S}$ - solar panel area (m[2])
$\boldsymbol{\tau}$ – light emission capacity of the solar panel (0.85)
$\boldsymbol{\eta_{sp}}$- useful work coefficient of the solar panel (0.15)
$\boldsymbol{\eta_0}$- useful work coefficient of energy conversion and transmission to the consumer (0.83)
$\boldsymbol{\eta_0}$ - is calculated in the following manner

$$\eta_0 = K * \eta_{conv} * \eta_{tran} \quad (2)$$

here
η_{conv} – conversion – useful efficiency of conversion (0.9)
η_{tran} – transmission-is the useful efficiency of the transmission (0.95)
K – is the coefficient according to the angle of inclination of the panel.

When the inclination angle is equal to the width of the point, K=1.3, that is, the radiation increases by 30%.

Accepting the above coefficients, we can calculate the technical potential of solar energy in the following manner:

$$E_{tex} = E_{tot} * 1 * 0.85 * 0.12 * 0.83 = 0.085 * K * E_{tot} \quad (3)$$

Table 1 shows the potential of solar energy calculated in the above manner. For a given solar installation, the average annual technical potential of the area with horizontal panels is 121.23 kWh per square meter. At this time, the average technical potential of the area fluctuates between 100-160 kWh.

We find the average technical power of solar installations as follows:

$$\bar{P} = \frac{E_{tex}}{8760} \quad (4)$$

The power of technical potential is 8-15 W/m[2] in January, and 22-36 W/m[2] in July. Average annual prices are 15-23 W/m[2].

The solar energy potential of the Republic of Azerbaijan and its administrative regions was calculated separately using the above formulas, data from hydrometeorological stations and research results of ANAS institutes. Areas suitable for agriculture, areas of forest funds were not taken into account in the calculations (parameters for several cities and regions are presented in Table 1).

Table 1: *Solar energy potential of the administrative regions of the Republic of Azerbaijan*

№	The name of the areas	Common area, huh	K/t usable area, huh	K/t usable area, huh	Areas suitable for the use of solar energy, yes
1	Aghdam	137221	90376	1014	45831
2	Agdash	94720	52401	7568	34751
3	Agstafa	123996	76175	6489	41332
4	Nax.MR;	536300	157165	4158	374977
5	Nagorno-Karabakh	497951	220004	128769	149178
6	Baku general	187416	4973	0	182443
7	Sumgait general	10865	1056	0	9809
8	Ganja	8307	900	0	7407
9	total for Azerbaijan;	8641506	4514473	1063480	3063553

Using solar radiation parameters, the technical potential of administrative regions, large cities and the country as a whole was determined (Table 2).

As can be seen from the tables, the solar energy potential of the Republic of Azerbaijan is 47.5 billion kWh and the technical potential to be achieved with the solar panels to be installed is 43.2 thousand MW. Using this potential, it is possible to obtain a large amount of funds from the export of oil and gas resources of our country.

It is more efficient to use solar collectors in relatively warm areas of the country. Our newly designed solar collector is similar to the solar collector used for air heating with a number of changes.

Table 2: *The technical potential of administrative regions was determined by using parameters of solar radiation*

№	The name of the areas	Duration of solar radiation, hours	Total radiation of solar energy (kW*h/m2)	Potential power of annual total (flatly scattered) radiation (W/m2)	Technical potential of total solar radiation falling on areas suitable for use of solar energy, (GWh*h)	The power of solar panels installed in the purchase of technical potential, MW
1	Aghdam	2310	1499,51	160	687	595
2	Agdash	2400	1450	160	504	420
3	Agstafa	2350	1550	175	641	545
4	Nax.MR;	2760	1717	195	6438	4665
5	Nagorno-Karabakh	2200	1200	150	1790	1627
6	Baku general	2244	1455,99	165	2656	2368
7	Sumgait general	2200	1400	160	137	125
8	Ganja	2320	1504,78	160	111	96
9	total for Azerbaijan;	2200	1552	162	47546	43224

Stainless steel plates with a thickness of 0.5 - 2 mm are used in the preparation of the solar collector to increase the service life and reduce the cost (Fig. 2). As you can see, the lower part of the solar collector is made of a rectangular prism, and the upper part is made of a trapezoidal prism. In the lower part, the water is heated by the sun's rays, moves up and is put to use. In order to reduce heat losses, the lower part of the solar collector is covered with heat insulating material.

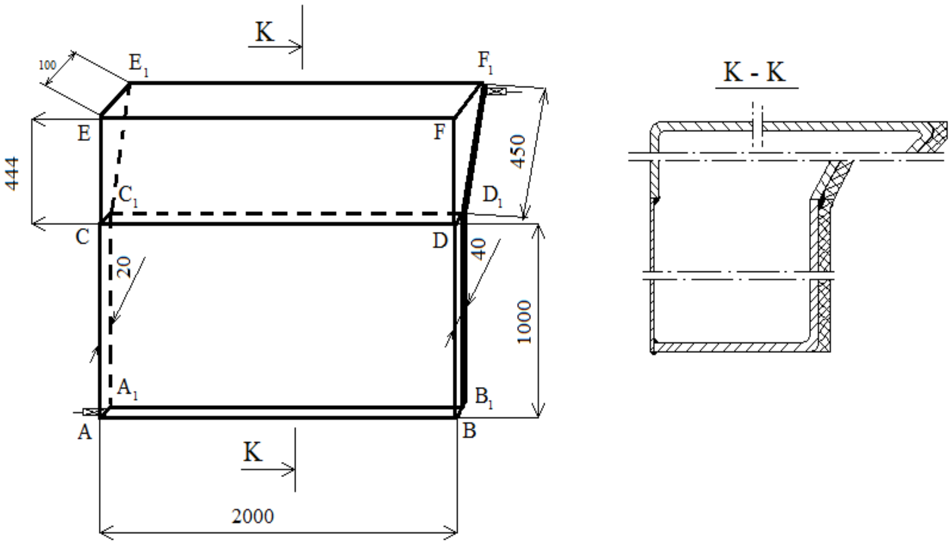

Figure 2: *Stainless steel plates*

Experiments were carried out in the middle of July on the Absheron Peninsula using the provided solar collector, and it was determined that the highest water temperature was obtained through the solar collector around 16:00.

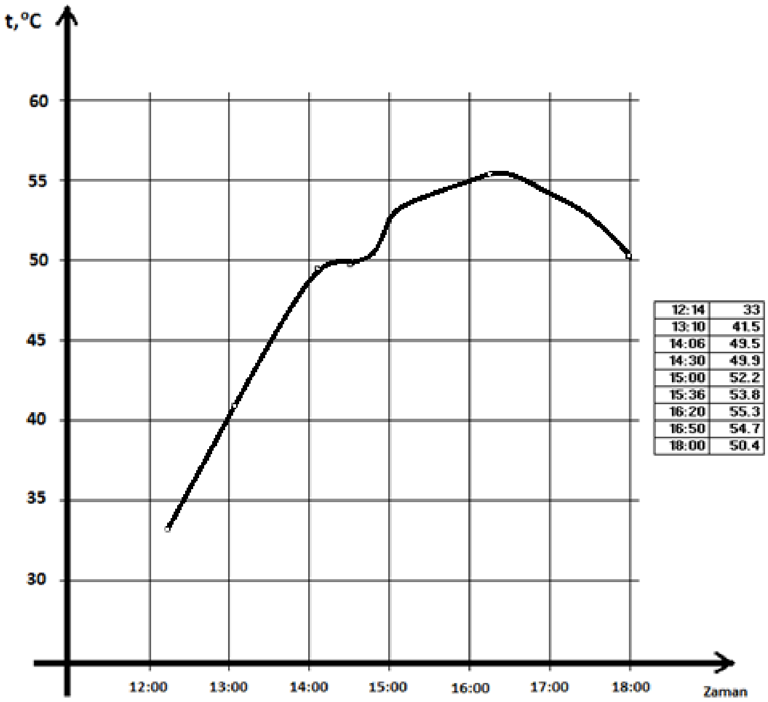

Figure 3: *Water temperature*

Our country has great resources for the production of both electricity and heat energy from solar energy. Investments by the public and private sector are essential for the utilization of these resources. With this, new jobs will be opened, energy security, environmental cleanliness and export potential of traditional energy resources will be achieved.

IV. Conclusion

Expanding the use of solar energy is one of the important tasks in the direction of reducing greenhouse gases in our country. Huge projects are being implemented in our country in the direction of purchasing electricity from solar energy, but the production of thermal energy is just as important.

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